The OGS experience in rapid determination of source parameters and ShakeMaps for NE Italy

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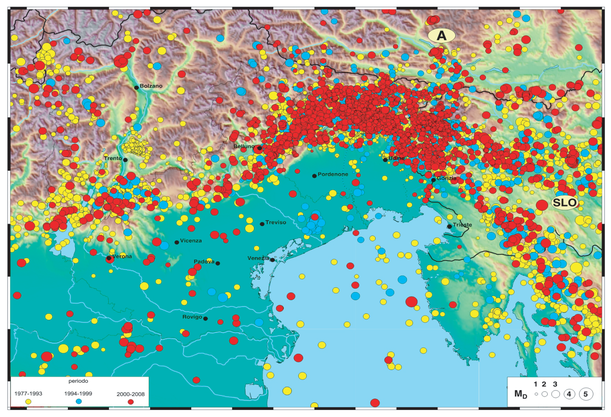
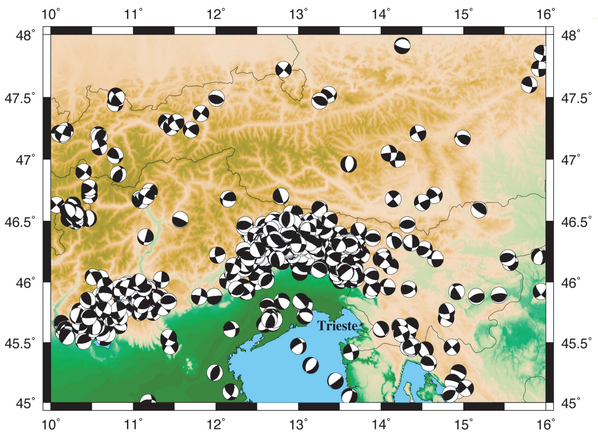
The seismicity of NE Italy



Map of NE seismicity 1977-2008 (courtesy of Sandro Urban)

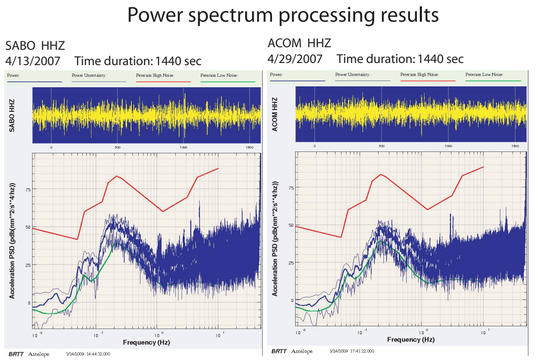
Data from the OGS bullettin: http://www.crs.inogs.it/bollettino/RSFVG/RSFVG.en.html



Map of focal mechanisms of earthquakes occurred between 1928 and 2008 (Saraò, 2008)

Seismicity of North-East Italy demarcates the boundary between the Adria microplate and the Eurasian plate. The actual state of stress is a consequence of the Adria microplates progressive motion and its anti-clockwise rotation with respect to the Eurasian plate. The seismotectonic characteristics of the region are not homogeneous, and the contemporary seismic deformation pattern is quite complex, being the results of the superimposition of several distinct strain fields related to different Alpine phases. The last severe earthquake was the 1976 Ms=6.5 Friuli earthquake, which caused lot of damage and hundreds of casualties.

The seismic network of NE Italy

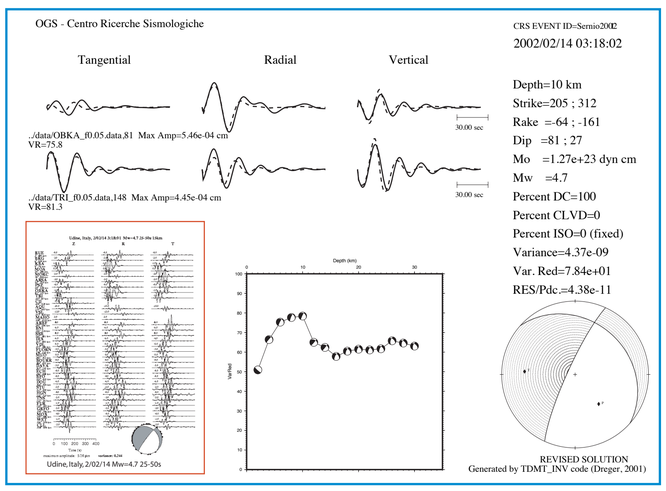


Examples of PSD for two broad-band stations of the network.

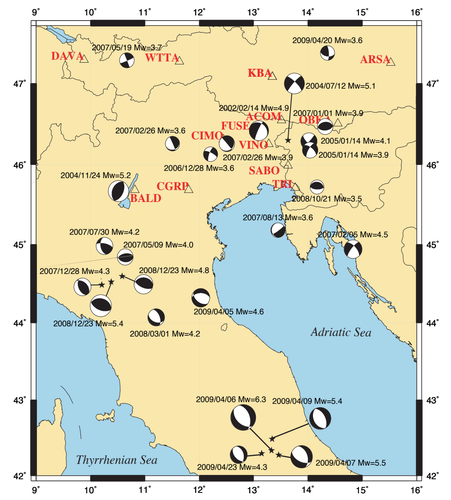
OGS manages an integrated seismic network designed to monitor regional seismic activity of North-East Italy (NI) and surroundings. The network includes 11 digital broadband seismometers and 27 short period stations. Waveforms and parametric data are exchanged in real time with the local Civil Defence agencies, the INGV, the Earth Science Department of the University of Trieste, the Zentralanstalt für Meterologie und Geodynamik (ZAMG) in Vienna, and the Agencija Republike Slovenije za Okolje (ARSO) in Ljubljana, in order to support emergency management and seismological studies in the whole Alps–Dinarides junction zone. The Antelope software suite from BRTT has been chosen as the common basis for real time data exchange, rapid location of earthquakes and alerting.

Automatic moment tensor solutions

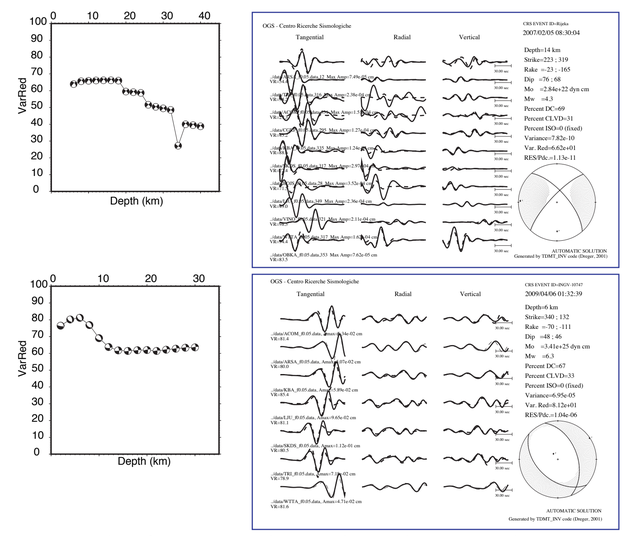
We implemented, tested and tuned for NE Italy the TDMT_INV code (Dreger, 2001). Several tests, using synthetic and real data, have been performed to check the sensitivity of solutions to the NI broadband network geometry, to the number of stations employed as well as to the 1D velocity models used. Our tests revealed that the best double couple and the Mw are quite robust and that one or two-station solutions can be effective in many cases. At date, the automatic procedures is activate for the earthquakes located in NE Italy and surroundings, starting from M_L=3.7.



Moment tensor solution obtained using two stations. The SED solution is also reported for comparison.



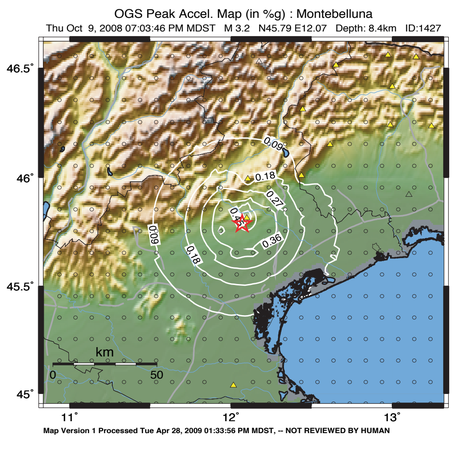
Moment tensors computed using OGS data.

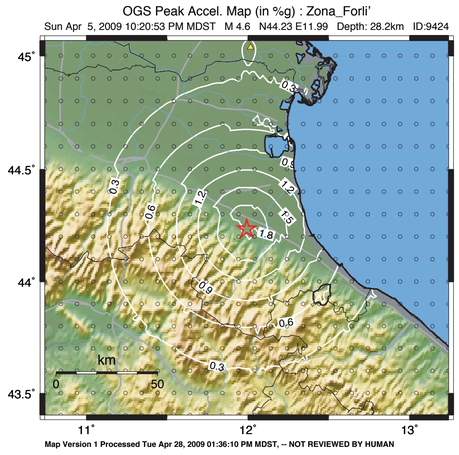


Examples of automatic solutions obtained using OGS data.

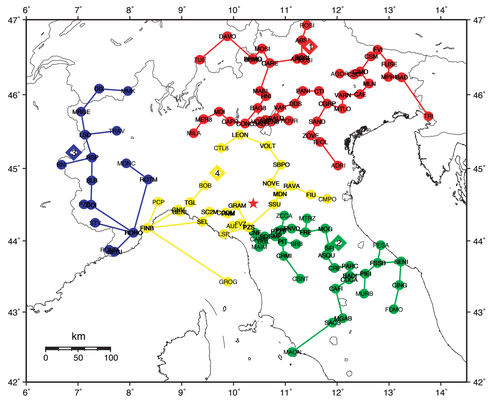
Shakemap

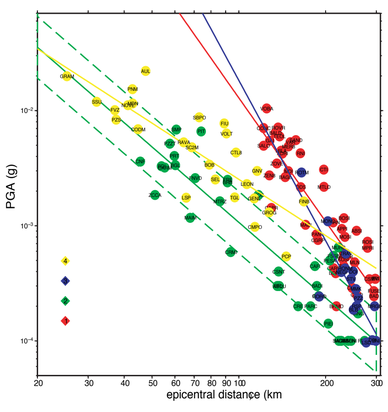
ShakeMap software (Wald et al., 2006) customized for Italy by INGV is installed at OGS and efforts have been made for ensuring the coherency with the maps of ground-motions computed at other Italian data centers for the same earthquake. Protocols for parametric data exchange are under development.





In the framework of the validation of the Shakemap results, we have assessed the impact of regional and site characteristics on the uncertainty of ground-motion predictive equations available for Italy. Using INGV data we demonstrated that site conditions contribute to about 30% of such uncertainty, while regional characteristics contribute for less than 4%, with major differences (higher acceleration for the same magnitude and distance from the source) located in north-eastern Italy (more details in Bragato 2009).





PGA values vs. epicentral distance observed for the 2008/12/23 Parma earthquake (Mw=5.4). The solid lines represent the regression curves estimated for different italian regions. The dashed lines indicates +/- one standard deviation (0.25) associated to the green line (attenuation along the Apennines).

NE PGA values are 4 times greater than the corresponding values observed along the Apennines.

Acknowledgments

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References

Bragato P. L. (2009). Assessing regional and site-dependent variability of ground motions for ShakeMap implementation in Italy. BSSA in press.

Dreger D. S. (2003). Time-Domain Moment Tensor INVerse Codel (TDMT-INVC) Release 1.1. International Handbook of Earthquake and Engineering Seismology, W. H.. K. Lee, H. Kanamori, P. C. Jennings, and C. Kisslinger (Editors), Vol B, 1627 p.

Saraò A. (2007). Seismic moment tensor determination at CRS: feasibility study. Open Report, OGS 2007/60-CRS/16. 43 pp.

Saraò A. (2008). Focal mechanisms of NE Italy and surroundings (1928-2008). Report OGS 2008/143-CRS/20 MODES, 73 pp. Trieste.

Wald D.J., Worden C.B., Quitoriano V. and K.L. Pankow (2006). ShakeMap® Manual, technical manual, users guide, and software guide http://pubs.usgs.gov/tm/2005/12A01/pdf/508TM12-A1.pdf, 156 pp.

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